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# Hitachi Unified Compute Platform 6000 for Oracle Real Application Clusters on Two Nodes Using Hitachi Virtual Storage Platform G600 with NAS Modules and Hitachi Compute Blade 2500

## Reference Architecture Guide

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# Feedback

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## Revision History

| Revision | Changes | Date |
|---|---|---|
| **AS-584-00** | **Initial release** | **March 17, 2017** |

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# Hitachi Unified Compute Platform 6000 for Oracle Real Application Clusters on Two Nodes Using Hitachi Virtual Storage Platform G600 with NAS Modules and Hitachi Compute Blade 2500

## Reference Architecture Guide

Hitachi customers want to deploy a variety of Oracle Solutions leveraging the NFS protocol on Hitachi NAS Platform (HNAS) to take advantage of the inherent simplicity and flexibility afforded by file-based solutions that reside on 10 GbE networks.

As part of Hitachi Virtual Storage Platform G series, Hitachi NAS Platform provides a number of compelling features that may be used to provide additional unique value to customers in the areas of performance, storage efficiency and ease of use.

This solution shows how to deploy Hitachi servers with Hitachi Virtual Storage Platform G600 (VSP 600) with NAS modules to provide a flexible NFS-based solution. The solution will:

- Establish best practices for running Oracle 12c RAC on Hitachi Virtual Storage Platform G600 with NAS modules
- Create a reference architecture for an Oracle 12c RAC on Hitachi Virtual Storage Platform G600 with NAS modules solution

This reference architecture guide shows how using Hitachi Virtual Storage Platform Gx00 with NAS modules for a two-node Oracle Real Application Cluster provides an integrated solution. The documented environment uses VSP G600 with NAS modules. Use this document to design an infrastructure for your requirements and budget.

This validated solution integrates servers, storage systems, network, and storage software. The environment provides reliability, high availability, scalability, and performance while processing small-scale to large-scale OLTP and DSS workloads. The dedicated servers run Oracle Database 12c R1 with the Oracle Real Application Cluster (RAC) option. The operating system is Oracle Linux 7.2.

This reference architecture document is for the following roles:

- Database administrator
- Storage administrator
- IT professional with the responsibility of planning and deploying an Oracle Database solution

To use this reference architecture guide, familiarity with the following is required:

- Hitachi Virtual Storage Platform G600 (VSP G600) with NAS modules
- Hitachi Compute Blade 2500 (CB 2500)
- 10 GbE Ethernet networks
- Oracle RAC Database 12c Release 1
- Oracle Linux

## Solution Overview

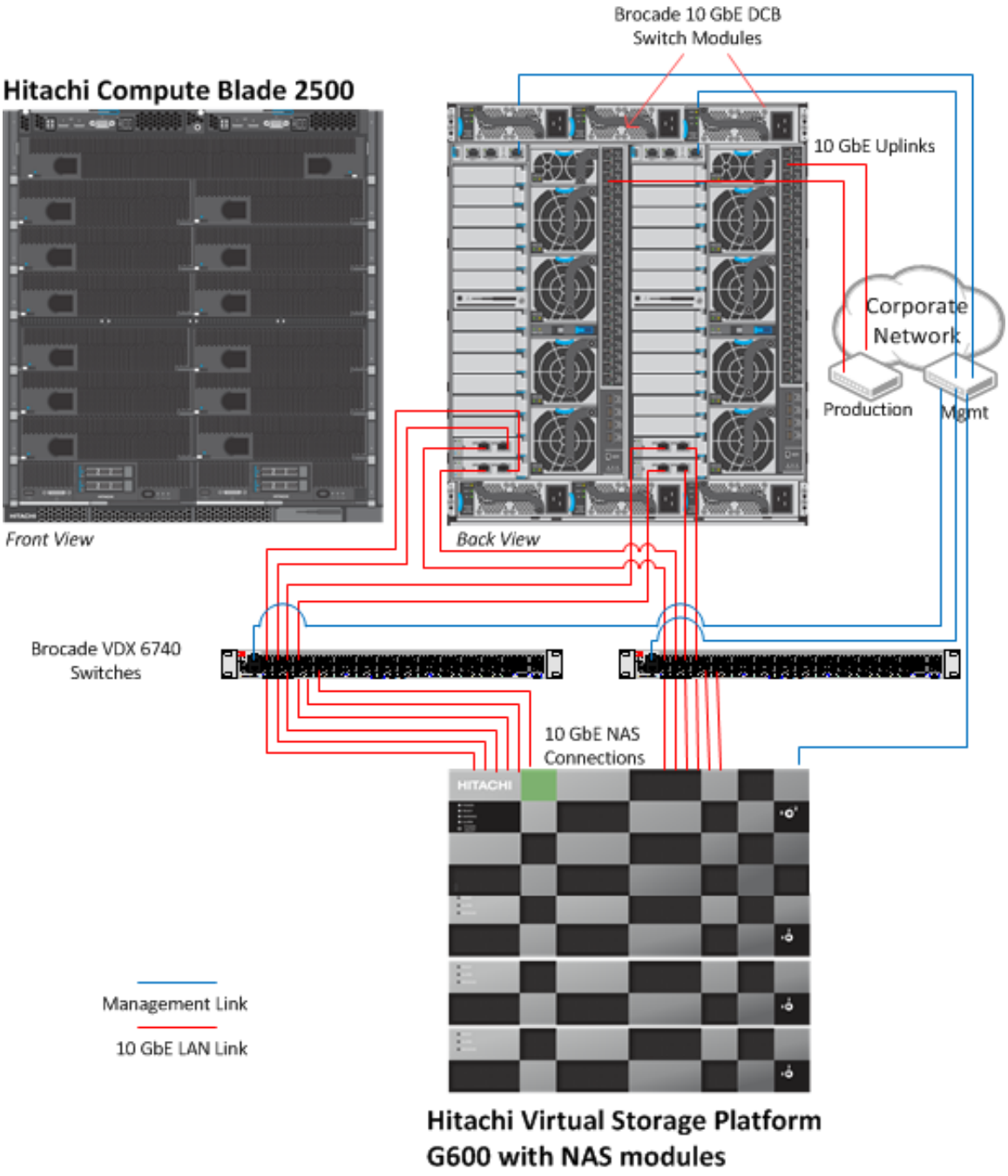
This reference architecture implements a two-node Oracle Real Application Cluster environment using Hitachi Virtual Storage Platform G600 (VSP G600) with NAS modules. This environment addresses the high availability, performance, and scalability requirements for on-line transaction processing (OLTP). Tailor your implementation of this solution to meet your specific needs.

This reference architecture includes the following:

- Hitachi Compute Blade 2500 with two server blades
  - Server Blade 1 — Oracle RAC NODE 1
  - Server Blade 2 — Oracle RAC NODE 2
- Hitachi Virtual Storage Platform G600 with NAS modules
- Dedicated 10 GbE infrastructure for NFS traffic
- 10 GbE LAN infrastructure

Figure 1 shows the high-level infrastructure for this solution.

**Figure 1**




While only one 10 GbE connection is shown from each DCB switch to the production corporate network in Figure 1, the actual number of connections depends on the specific customer environment and the customer bandwidth requirements.

## Key Solution Components

Table 1 lists the key hardware components used in this reference architecture.

**TABLE 1. KEY HARDWARE COMPONENTS**

| Hardware | Detail Description | Version | Quantity |
|---|---|---|---|
| Hitachi Virtual Storage Platform G600 (VSP G600) with NAS Modules | Two Controllers<br>Two HFB (NAS) Modules<br>12 × 10 Gb/sec 10GbE Ports (6 per NAS module)<br>16 × Backend SAS Ports<br>256 GB cache memory<br>24 × 1.6 TB FMD drives<br>4 × 1.2 TB 10k SAS drives | 83-04-01-40/00 | 1 |
| Hitachi Compute Blade 2500 chassis | 2 × 10 Gb/sec DCB LAN Switch Modules<br>10 × Fan Modules<br>6 × Power Supply Modules<br>2 × Management Modules | Management Module Firmware Version A0165-C-1467<br>Dictionary Version A0032<br>DCB Switch Firmware Version 4.0.1_hit1 | 1 |
| 520H B4 Half-width Blade | 2 × Intel Xeon E5-2699v4 3.6GHz CPU<br>256GB (16 GB × 16) DDR4<br>2 × 10 GbE dual port LAN adapter cards<br>2 × 300 GB 15k SAS drives | 10-06 | 2 |
| Brocade VDX 6740 | 48 port 10 GbE switch | 5.0.1d | 2 |

Table 2 lists the key software components used in this reference architecture.

**TABLE 2. KEY SOFTWARE COMPONENTS**

| Software | Version | Function |
|---|---|---|
| Hitachi Storage Navigator | N/A | Storage management |
| Hitachi Dynamic Provisioning | Microcode dependent | Storage license |
| Oracle Linux | 7.2 | Operating system |
| Oracle Database | 12c Release 1 (12.1.0.2.0) | Oracle Database system |
| Oracle Grid Infrastructure | 12c Release 1 (12.1.0.2.0) | Clusterware |
| Network File System (NFS) | V3 | Distributed file system protocol |
| ORION | Oracle version dependent | Workload generator |
| peakmarks | 9.2 | Workload suite |

## Hitachi Compute Blade 2500

Hitachi Compute Blade 2500 delivers enterprise computing power and performance with unprecedented scalability and configuration flexibility. Lower your costs and protect your investment.

Flexible I/O architecture and logical partitioning allow configurations to match application needs exactly with Hitachi Compute Blade 2500. Multiple applications easily and securely co-exist in the same chassis.

Add server management and system monitoring at no cost with Hitachi Compute Systems Manager. Seamlessly integrate with Hitachi Command Suite in Hitachi storage environments.

## Hitachi Virtual Storage Platform G600 with NAS modules

Hitachi Virtual Storage Platform Gx00 models are based on industry-leading enterprise storage technology. With flash-optimized performance, these systems provide advanced capabilities previously available only in high-end storage arrays. With the Virtual Storage Platform Gx00 models, you can build a high performance, software-defined infrastructure to transform data into valuable information.

Hitachi Storage Virtualization Operating System (SVOS) provides storage virtualization, high availability, superior performance, and advanced data protection for all Virtual Storage Platform Gx00 models. This proven, mature software provides common features to consolidate assets, reclaim space, extend life, and reduce migration effort.

Hitachi Virtual Storage Platform G600 provides an always-available, agile, and automated foundation that you need for a continuous infrastructure cloud. This delivers enterprise-ready software-defined storage, advanced global storage virtualization, and powerful storage.

Supporting always-on operations, Virtual Storage Platform G600 includes self-service, non-disruptive migration and active-active storage clustering for zero recovery time objectives. Automate your operations with self-optimizing, policy-driven management.

This solution uses a high-performance, clustered file option for completely unified storage with added NAS modules. Automatic and user-transparent deduplication provides storage savings. You can combine the NAS modules with the data integrator to cloud feature to tier the storage of lesser-used files.

Virtual Storage Platform G600 with NAS modules supports Oracle Real Application Clusters.

## Hitachi Virtual System Manager Unit

There are two options for managing the NAS modules on the Hitachi Virtual Storage Platform G600.

- Embedded System Manager Unit (SMU) — Is an embedded active/standby SMU that runs as a Linux process inside the NAS modules. This is the default interface to manage the NAS modules.
- Virtual System Manager Unit (vSMU) — Is a virtual appliance with the SMU code loaded on top of a CentOS based OS. This allows for better ease of use, flexibility, and scalability.

The main differences between the two options are:

- The virtual SMU can manage up to ten NAS clusters
- The virtual SMU can generate and display performance graphs

A virtual SMU was installed for the environment used for this reference architecture and was used to configure and manage the NAS modules. It was also used to monitor performance during test runs.

## Hitachi Storage Virtualization Operating System

Hitachi Storage Virtualization Operating System spans and integrates multiple platforms. It integrates storage system software to provide system element management and advanced storage system functions. Used across multiple platforms, Storage Virtualization Operating System includes storage virtualization, thin provisioning, storage service level controls, dynamic provisioning, and performance instrumentation capabilities.

Storage Virtualization Operating System (SVOS) includes standards-based management software on a Hitachi Command Suite base. This provides storage configuration and control capabilities for you.

Storage Virtualization Operating System uses Hitachi Dynamic Provisioning (HDP) to provide wide striping and thin provisioning. Dynamic Provisioning provides one or more wide-striping pools across many RAID groups. Each pool has one or more dynamic provisioning virtual volumes (DP-VOLs) without initially allocating any physical space. Deploying Dynamic Provisioning avoids the routine issue of hot spots that occur on logical devices (LDEVs).

## Brocade Switches

Brocade and Hitachi Data Systems partner to deliver storage networking and data center solutions. These solutions reduce complexity and cost, as well as enable virtualization and cloud computing to increase business agility.

The solution uses the following Brocade products:

- Brocade VDX 2746, a 10 GbE switch module
- Brocade VDX 6740, a 48 port 10 GbE switch

## Oracle Linux

Using the stability and flexibility of Oracle Linux, reallocate your resources towards meeting the next challenges instead of maintaining the status quo. Deliver meaningful business results by providing exceptional reliability of military-grade security. Use Oracle Linux to tailor your infrastructure as markets shift and technologies evolve.

## Oracle Database

Oracle Database has a multitenant architecture so you can consolidate many databases quickly and manage them as a cloud service. Oracle Database also includes in-memory data processing capabilities for analytical performance. Additional database innovations deliver efficiency, performance, security, and availability. Oracle Database comes in two editions: Enterprise Edition and Standard Edition 2.

Oracle Real Application Clusters (Oracle RAC) is a clustered version of Oracle Database. It is based on a comprehensive high-availability stack that can be used as the foundation of a database cloud system, as well as a shared infrastructure. This ensures high availability, scalability, and agility for any application.

Oracle Grid Infrastructure is portable cluster software that allows clustering of independent servers so that they cooperate as a single system. Oracle Grid Infrastructure is the required cluster technology for Oracle Real Application Clusters.

## Network File System NFS v3

NFS version 3 was used as the distributed file system protocol for this solution. dNFS could be used but additional network resources are required since dNFS does not support OCR or Voting devices for Oracle Grid Infrastructure in Oracle RAC 12c Release 1 (12.1.0.2.0).

# Solution Design

This describes the reference architecture environment, implementing a two-node Oracle Real Application Cluster using Hitachi Virtual Storage Platform G600 with NAS modules.

Specific infrastructure configuration details include the following:

- Server — Two server nodes configured in an Oracle Real Application Cluster.
- Storage System — There are LDEVs mapped to the NAS modules. Configuration of these LDEVs on the NAS modules is covered in the NAS Architecture section.
- Dedicated 10 GbE network — This network handles the NFS traffic between the NAS modules on VSP G600 and the two Oracle nodes.

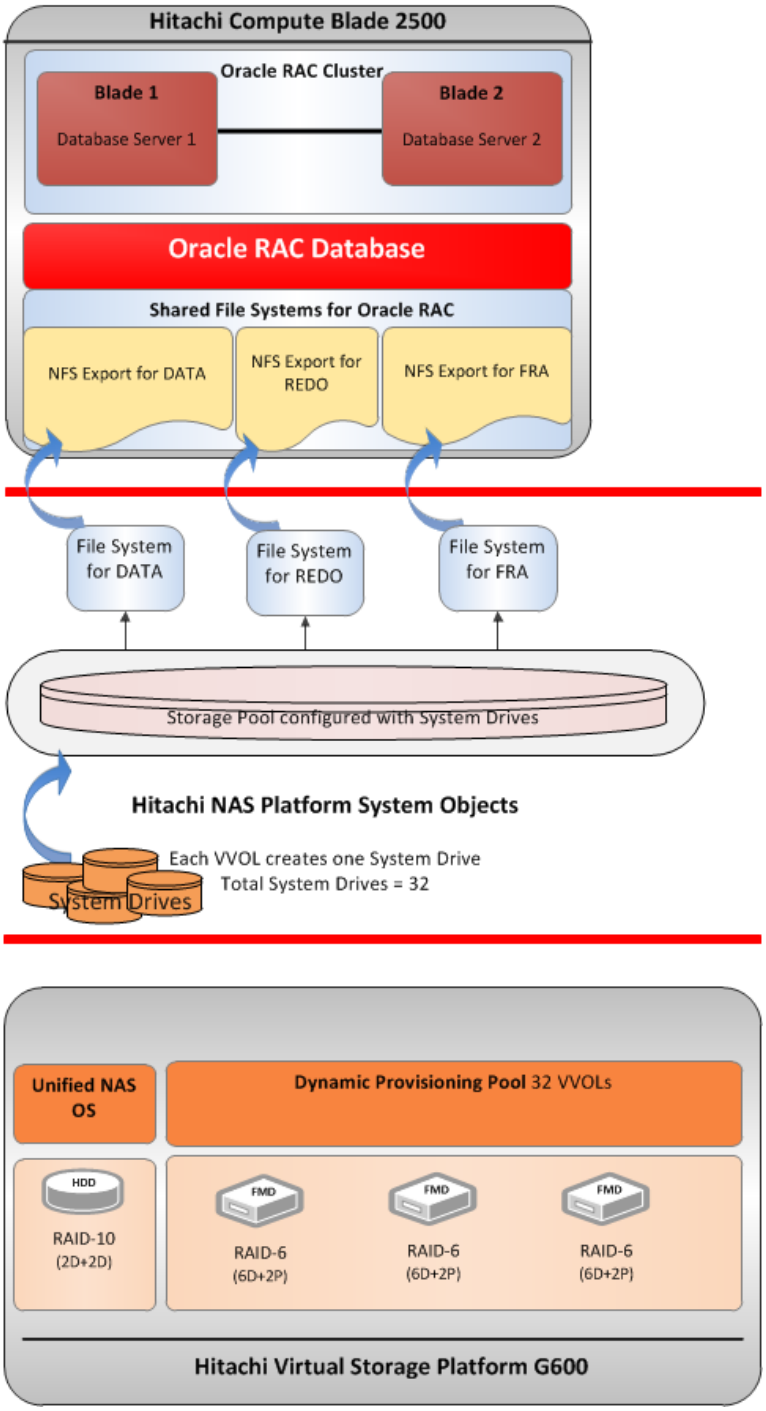
## Storage Architecture

This describes the storage architecture of this reference architecture. It takes into consideration Hitachi Data Systems and Oracle recommended practices for the deployment of database storage design.

### *Storage Configuration*

Figure 2 shows the high-level storage configuration used for this solution.

**Figure 2**




A single Hitachi Dynamic Provisioning pool is used for the Oracle environment. This is built on three RAID-6 (6D+2P) RAID groups. 32 LDEVs were created on each RAID group and used for pool volumes. The HDP pool was created from 96 LDEVs. 32 VVOLs were created in this pool and mapped to both NAS modules. These 32 VVOLs are used as system drives in the NAS modules. These system drives are then used to create a single storage pool consisting of a single 32 system drive stripeset.

The use of a single stripeset instead of multiple stripesets is based on Hitachi Data Systems recommended practices. Using a single stripeset per storage pool allows for maximum scaling and flexibility.

The size of the storage pool may need to be modified to meet the requirements of the customer environment. It is recommended that you increase or decrease the capacity of the underlying storage by increasing the size or number of RAID groups used. If possible, keep the number of VVOLs (NAS system drives) at 32 to maintain a single stripeset per storage pool.

Table 3 shows the storage pool configuration on the Hitachi Virtual Storage Platform G600.

**TABLE 3. STORAGE POOL CONFIGURATION**

| HDP Pool | HDP RAID Configuration | Number of Drives | Number of LDEVs per RAID Group | Drive Capacity | HDP Capacity |
|---|---|---|---|---|---|
| 0 | RAID-6 (6D+2P) | 24 | 32 | 1.6 TB FMD | 28.8 TB |

The NAS OS is hosted on a single RAID-10 (2D+2D) RAID group made up of 1.2 TB SAS 10k drives. This is the standard configuration but other drive types and sizes can be used.

On the NAS modules three file systems were created on the storage pool. The file system details are listed in Table 4.

**TABLE 4. NAS FILE SYSTEM CONFIGURATION**

| File System | Capacity | EVS Assignment |
|---|---|---|
| OraRAID6DATA-FS | 13.00 TB | OraRAID6Data |
| OraRAID6FRA-FS | 13.00 TB | OraRAID6FRA |
| OraRAID6Redo-FS | 1018.38 GB | OraRAID6Redo |

The size of each file system in a production environment will depend on the customer requirements.

The block size for the file systems were set to 4 KB. This setting gives the best overall performance for an Oracle RAC environment.

The default settings are recommended for the three file systems, except quickstart should be disabled on the data and redo file systems.

An NFS export was created for each file system. The NFS export details are listed in Table 5.

TABLE 5. NFS EXPORT CONFIGURATION

| NFS Export | File System | Path | Host NFS Mount Point |
|---|---|---|---|
| /OraRAID6-Data | OraRAID6Data-FS | /oraraid6-data | /u02/data |
| /OraRAID6-FRA | OraRAID6FRA-FS | /oraraid6-fra | /u02/fra |
| /OraRAID6-Redo | OraRAID6Redo-FS | /oraraid6-redo | /u02/redo |

Each NFS export had the following options set in the access configuration field:

- *(rw,no_root_squash)

The EVSs were assigned to the NAS cluster nodes and link aggregations as shown in Table 6.

TABLE 6. EVS CONFIGURATION

| EVS | NAS Cluster Node | Link Aggregate |
|---|---|---|
| OraRAID6Data | 1 | ag1 |
| OraRAID6FRA | 2 | ag2 |
| OraRAID6Redo | 2 | ag2 |

The link aggregation and NFS network details are documented in the Network Architecture - NFS section later in this paper.

## Database Layout

The database layout design uses recommended practices from Hitachi Data Systems for Hitachi Virtual Storage Platform G600 with NAS modules for small random I/O traffic, such as OLTP transactions. The layout also takes into account Oracle best practices when using Hitachi storage.

Base the storage design for database layout needs on the requirements of a specific application implementation. The design can vary greatly from one implementation to another. The components in this solution set have the flexibility for use in various deployment scenarios to provide the right balance between performance and ease of management.

- **Data and Indexes Tablespaces** — Datafiles for data and indexes tablespaces are created from file system 'OraRAID6-Data'. The smallfile tablespace for data consists of 2048 datafiles that are 8 GB each.
- **TEMP Tablespace** — Create a bigfile temporary tablespace from file system 'OraRAID6-Data' in this configuration.
- **Undo Tablespace** — Create two bigfile UNDO tablespaces from file system 'OraRAID6-Data'. Assign one UNDO tablespace for each database instance in this 2-node Oracle RAC database.
- **Online Redo Logs** — Assign a dedicated file system, 'OraRAID6-Redo', for online redo logs. Four redo logs are created for each database instance in a two-node Oracle RAC database. Set the size of each redo log file to 8 GB.
- **Oracle Cluster Registry and Voting Disk** — Place each of these files in file system 'OraRAID6-FRA' in this 2-node Oracle RAC configuration.
- **Size Settings** — Set the database block size to 8 KB. Set the NAS file system block size to 4 KB.

In this architecture, Network File System (NFS) on the network-attached storage (NAS) filer is used as the storage option for Oracle Clusterware and Oracle RAC. This simplifies the Oracle Grid Infrastructure installation and configuration. Oracle Automatic Storage Management (Oracle ASM) is not required.

Table 7 lists the Oracle environment parameters.

**TABLE 7. ORACLE ENVIRONMENT PARAMETERS**

| For This Setting | Use This Value |
|---|---|
| SGA_TARGET | 128 GB |
| PGA_AGGREGATE_TARGET | 64 GB |
| DB_CACHE_SIZE | 64 GB |
| DB_KEEP_CACHE_SIZE | 32 GB |
| DB_RECYCLE_CACHE_SIZE | 8 GB |
| LOG_BUFFER | 512 MB |
| USE_LARGE_PAGES | TRUE |
| FILESYSTEMIO_OPTIONS | SETALL |

The three NFS exports are mounted on both RAC nodes. The /etc/fstab file has the following mount options defined.

- 192.168.99.5:/OraRAID6-Data /u02/data nfs rw,bg,hard,nointr,tcp,vers=3,timeo=600,rsize=65536,wsize=65536,actimeo=0 0 0
- 192.168.98.5:/OraRAID6-FRA /u02/fra nfs rw,bg,hard,nointr,tcp,vers=3,timeo=600,rsize=65536,wsize=65536,actimeo=0 0 0
- 192.168.98.6:/OraRAID6-Redo /u02/redo nfs rw,bg,hard,nointr,tcp,vers=3,timeo=600,rsize=65536,wsize=65536,actimeo=0 0 0

When the NFS exports are mounted they have the following settings.

- 192.168.99.5:/OraRAID6-Data on /u02/data type nfs (rw,relatime,vers=3,rsize=65536,wsize=65536,namlen=255,acregmin=0,acregmax=0,acdirmin=0,acdirmax=0,hard,proto=tcp,timeo=600,retrans=2,sec=sys,mountaddr=192.168.99.5,mountvers=3,mountport=4048,mountproto=tcp,local_lock=none,addr=192.168.99.5)
- 192.168.98.5:/OraRAID6-FRA on /u02/fra type nfs (rw,relatime,vers=3,rsize=65536,wsize=65536,namlen=255,acregmin=0,acregmax=0,acdirmin=0,acdirmax=0,hard,proto=tcp,timeo=600,retrans=2,sec=sys,mountaddr=192.168.98.5,mountvers=3,mountport=4048,mountproto=tcp,local_lock=none,addr=192.168.98.5)
- 192.168.98.6:/OraRAID6-Redo on /u02/redo type nfs (rw,relatime,vers=3,rsize=65536,wsize=65536,namlen=255,acregmin=0,acregmax=0,acdirmin=0,acdirmax=0,hard,proto=tcp,timeo=600,retrans=2,sec=sys,mountaddr=192.168.98.6,mountvers=3,mountport=4048,mountproto=tcp,local_lock=none,addr=192.168.98.6)

The IP address assignment and configuration is documented in the Network Architecture - NFS section later in this paper.

The three mount points that are used are shown in Table 8.

**TABLE 8. FILE SYSTEM MOUNT POINTS**

| File System | NFS Export | Mount Point | Purpose |
|---|---|---|---|
| OraRAID6DATA-FS | /OraRAID6-Data | /u02/data | System<br>Sysaux<br>Temp<br>Undo<br>Users<br>Application Tablespace<br>Control Files |
| OraRAID6FRA-FS | /OraRAID6-FRA | /u02/fra | Archive Logs<br>Incremental Backups<br>Control File Autobackups<br>OCR |
| OraRAID6Redo-FS | /OraRAID6-Redo | /u02/redo | Online REDO log groups |

## Server and Application Architecture

This reference architecture uses a single Hitachi Compute Blade 2500 chassis with two 520H B4 server blades.

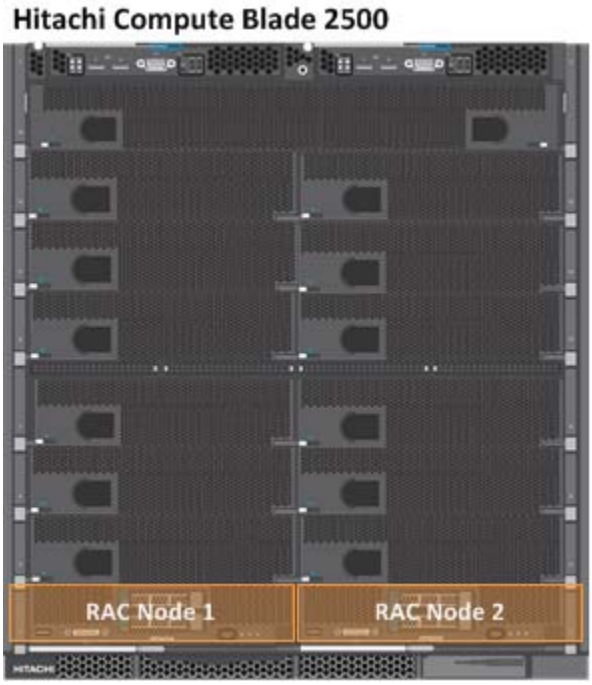
This provides the compute power for the Oracle RAC database. Table 9 describes the details of the server configuration for this solution.

**TABLE 9. BLADE SERVER CONFIGURATION**

| Server | Form Size | Server Name | Role | CPU Cores | RAM |
|---|---|---|---|---|---|
| Blade 1 | Half-width | Uninode1 | RAC Node 1 | 44 | 256 GB |
| Blade 2 | Half-width | Uninode2 | RAC Node 2 | 44 | 256 GB |

Figure 3 shows the server blade layout in the Hitachi Compute Blade 2500 chassis.

**Figure 3**




## Network Architecture

This architecture requires the following separate networks:

- Private Network (also called cluster interconnect) — This network must be scalable. In addition, it must meet the low latency needs of the network traffic generated by the cache synchronization of Oracle RAC and inter-node communication amongst the nodes in the cluster.
- Public Network — This network provides client connections to the applications and Oracle RAC.
- NFS Network — This network handles the data traffic between the NAS modules in the Hitachi Virtual Storage Platform G600 and the Oracle RAC nodes.

### *Private and Public Networks*

Hitachi Data Systems recommends using a pair of 10 Gb/sec NICs for the cluster interconnect and public network.

Each server blade in this reference architecture has a quad port 10 Gb/sec onboard NIC. The NIC ports have interconnected links to the two internal 10 Gb/sec Ethernet switches in the chassis. These NICs are used for the private and public networks.

Observe these points when configuring private and public networks in your Oracle RAC environment:

- For each server in the Oracle RAC clusterware configuration, use at least two identical, high bandwidth, low-latency NICs for the interconnection.
- Use NIC bonding or NIC teaming to provide fail over and load balancing.
- Set all NICs to full duplex mode.
- Use at least two public NICs for client connections to the application and database.
- Use at least two private NICs for the cluster interconnection.

Figure 4 shows the public and private network configuration for the reference architecture environment.

**Figure 4**

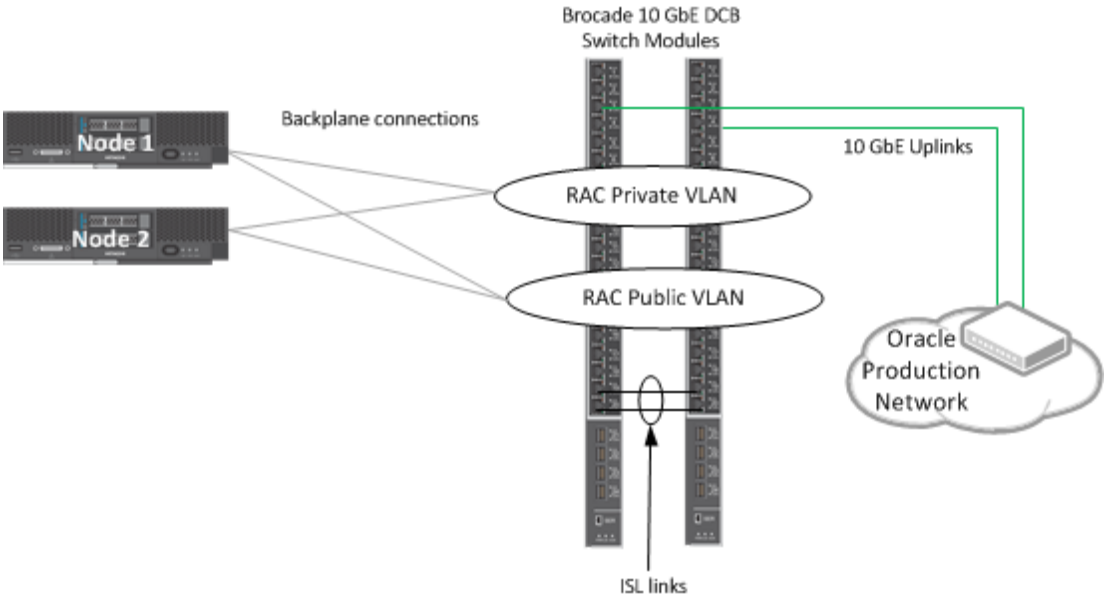



Table 10 lists the private and public network configuration for this solution. Configure the VLAN accordingly to fit your network environment.

**TABLE 10. PRIVATE AND PUBLIC NETWORK CONFIGURATION**

| Server | NIC Ports | UMC Phvsical Function Number | Switch Bay ID | Switch Ports (Internal) | VLAN | NIC BOND | Network | Bandwidth (Gb/sec) |
|---|---|---|---|---|---|---|---|---|
| Oracle RAC Node 1 | B1-CNIC-0 | 0 | 1 | 1 | 1 | Bond2 | Private | 10 |
| | B1-CNIC-1 | 1 | 2 | 1 | | | | 10 |
| | B1-CNIC-2 | 2 | 1 | 15 | 2 | Bond3 | Public Oracle | 9 |
| | | 6 | 1 | 15 | 3 | Bond4 | Public Management | 1 |
| | B1-CNIC-3 | 3 | 2 | 15 | 2 | Bond3 | Public Oracle | 9 |
| | | 7 | 2 | 15 | 3 | Bond4 | Public Management | 1 |

TABLE 10. PRIVATE AND PUBLIC NETWORK CONFIGURATION

| Server | NIC Ports | UMC Phvsical Function Number | Switch Bay ID | Switch Ports (Internal) | VLAN | NIC BOND | Network | Bandwidth (Gb/sec) |
|---|---|---|---|---|---|---|---|---|
| Oracle RAC Node 2 | B2-CNIC-0 | 0 | 1 | 2 | 1 | Bond2 | Private | 10 |
| | B2-CNIC-1 | 1 | 2 | 2 | | | | 10 |
| | B2-CNIC-2 | 2 | 1 | 16 | 2 | Bond3 | Public Oracle | 9 |
| | | 6 | 1 | 16 | 3 | Bond4 | Public Management | 1 |
| | B2-CNIC-3 | 3 | 2 | 16 | 2 | Bond3 | Public Oracle | 9 |
| | | 7 | 2 | 16 | 3 | Bond4 | Public Management | 1 |

*NFS Data Network*

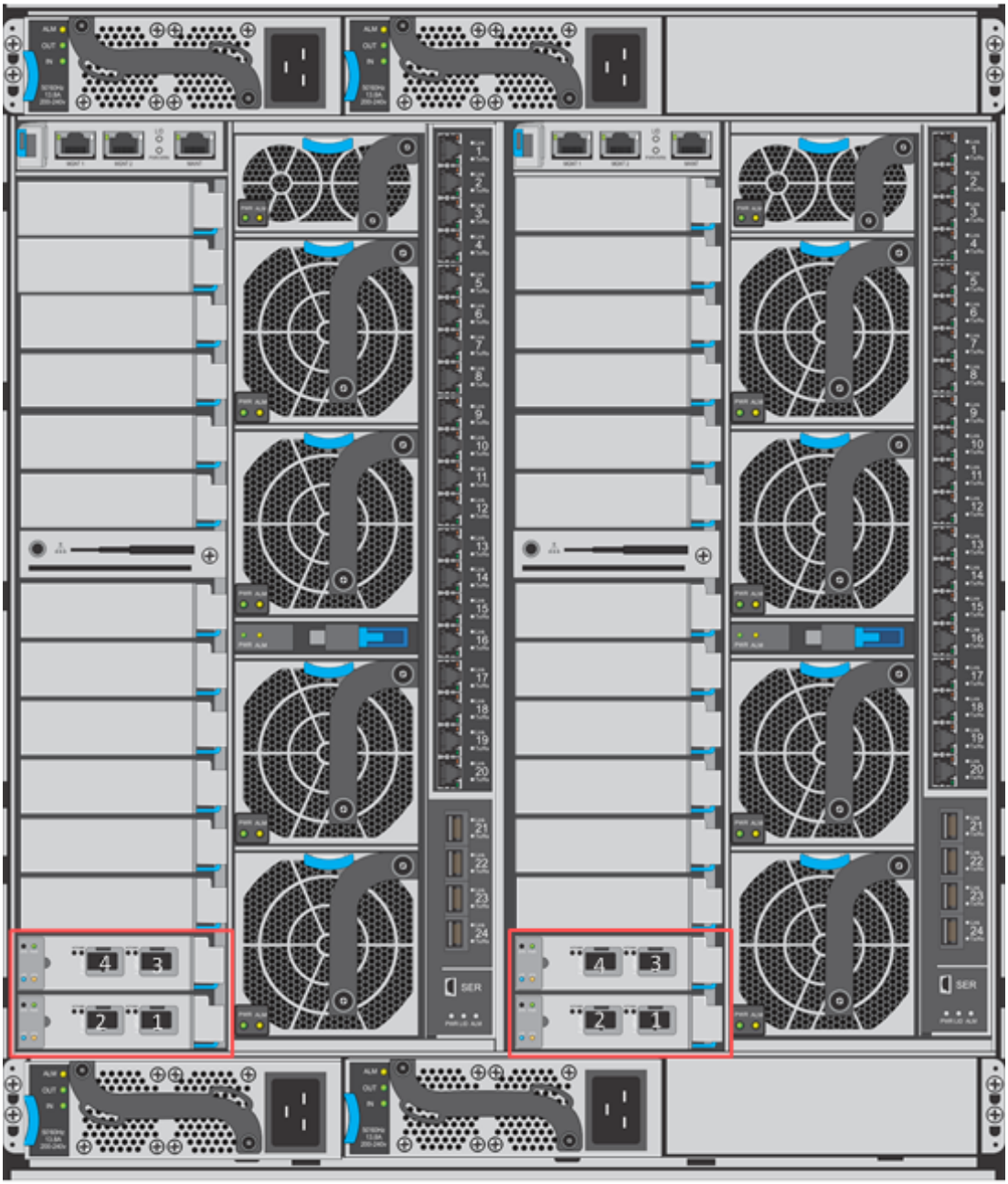
Each server blade also has two dual port 10 GbE LAN adapter cards installed in the I/O board slots in the back of the Hitachi Compute Blade 2500 chassis. These are connected via two Brocade VDX 6740 switches to the 10 GbE ports on the NAS modules in the Hitachi Virtual Storage Platform G600. Each NAS module has six 10 GbE NIC ports.

The two Brocade VDX 6740 switches were connected with two ISLs between port 9 on each switch and port 10 on each switch.

The dual port 10 GbE LAN adapter cards are shown in Figure 5.

**Figure 5**

**Hitachi Compute Blade 2500**



*Back View*

On each blade NIC 1 and NIC 4 are teamed together as team0, and NIC 2 and NIC 3 are teamed together as team1.

LACP (802.3ad) configuration is used on the server blades, Brocade switches, and NAS modules. On the server blades this is configured by using NIC teaming; on the Brocade switches port-channels are used, and on the NAS modules LACP is enabled on the link aggregations.

Jumbo frames should be enabled throughout the network used for NFS traffic. Failure to enable jumbo frames will result in substantial performance degradation.

Flow control was not enabled in the NFS network environment used for this reference architecture because all interfaces and connections were 10 GbE. If a mixture of 1 Gb and 10 Gb components were used, then flow control would need to be enabled.

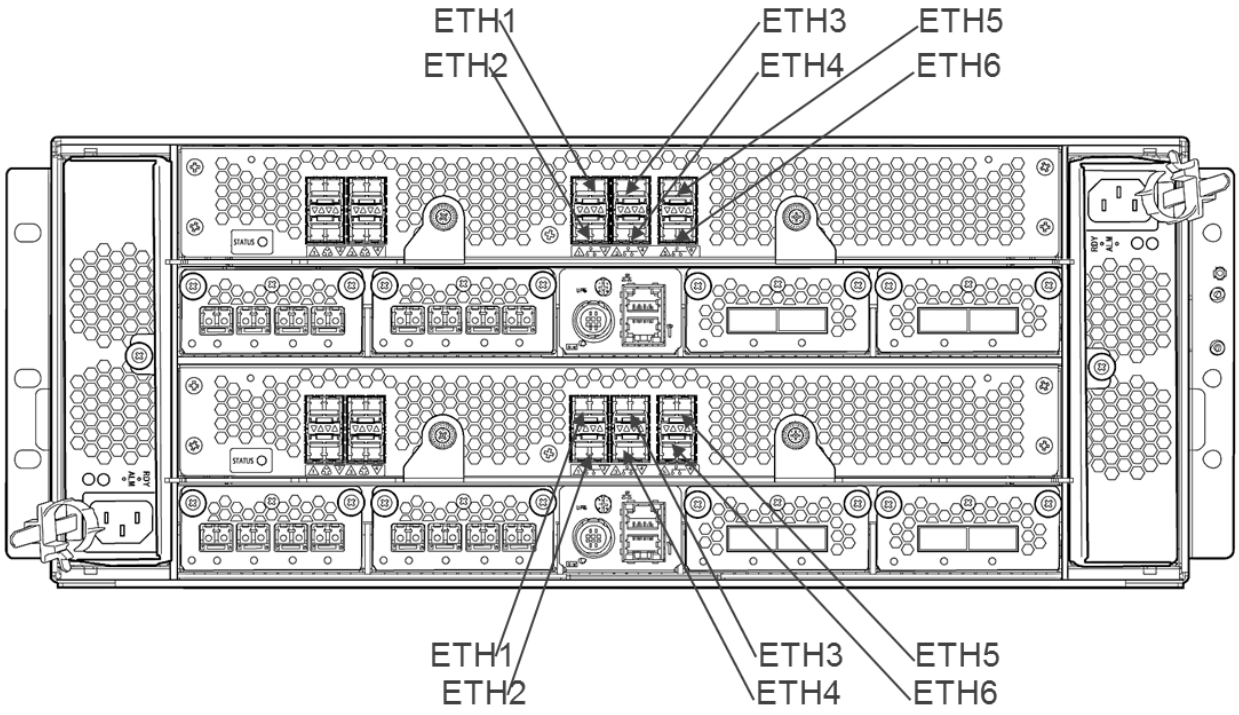
The connections between the 10 GbE ports on the Hitachi Compute Blade 2500 and the Brocade VDX 6740 switches are listed in Table 11.

**TABLE 11. NFS NETWORK CONFIGURATION - SERVERS**

| Server Blade | NIC | Switch | Switch Port | Port Channel | Subnet |
|---|---|---|---|---|---|
| Blade 1 | 1 | 2 | 2 | 41 | 192.168.99.0 |
| | 2 | 1 | 2 | 42 | 192.168.98.0 |
| | 3 | 2 | 4 | 42 | 192.168.98.0 |
| | 4 | 1 | 4 | 41 | 192.168.99.0 |
| Blade 2 | 1 | 1 | 6 | 31 | 192.168.99.0 |
| | 2 | 2 | 8 | 32 | 192.168.98.0 |
| | 3 | 1 | 8 | 32 | 192.168.98.0 |
| | 4 | 2 | 6 | 31 | 192.168.99.0 |

The 10 GbE connections on the NAS modules on the Hitachi Virtual Storage Platform G600 are shown in Figure 6.

**Figure 6**



NAS module 2 is the top module and NAS module 1 is the lower one.

The connections between the 10 GbE ports on the NAS modules and the Brocade VDX 6740 switches are listed in Table 12.

**TABLE 12. NFS NETWORK CONFIGURATION - NAS MODULES**

| NAS Module | NIC | Aggregate | Switch | Switch Port | Port Channel | Subnet |
|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 2 | 7 | 111 | 192.168.99.0 |
| | 2 | 1 | 1 | 5 | 111 | 192.168.99.0 |
| | 3 | 2 | 2 | 5 | 211 | 192.168.98.0 |
| | 4 | 2 | 1 | 7 | 211 | 192.168.98.0 |
| | 5 | 1 | 1 | 17 | 111 | 192.168.99.0 |
| | 6 | 1 | 2 | 17 | 111 | 192.168.99.0 |
| 2 | 1 | 1 | 2 | 3 | 112 | 192.168.99.0 |
| | 2 | 1 | 1 | 1 | 112 | 192.168.99.0 |
| | 3 | 2 | 2 | 1 | 212 | 192.168.98.0 |
| | 4 | 2 | 1 | 3 | 212 | 192.168.98.0 |
| | 5 | 1 | 1 | 18 | 112 | 192.168.99.0 |
| | 6 | 1 | 2 | 18 | 112 | 192.168.99.0 |

Port level load balancing on the NAS modules is set to Normal on the two link aggregates. The Normal setting is recommended over the Round Robin setting to avoid issues with packets being out of order.

## Test Results

This section summarizes the key observations from the test results for Oracle Real Application Cluster using Hitachi Virtual Storage Platform G600 with NAS modules and Oracle Orion and peakmarks.

Table 13 lists the Oracle Orion I/O test cases for this solution.

**TABLE 13. ORION TEST RESULTS FOR SINGLE NODE**

| Test Case | Metric | Value |
|---|---|---|
| 100% 8 KB Random Read | IOPS | 62,537 |
| | Latency | 1.4 ms |
| 75% 8 KB Random Reads + 25% 8 KB Random Write | IOPS | 54,288 |
| | Read Latency | 1.2 ms |
| | Write Latency | 1.2 ms |
| 100% 1 MB Sequential Read | Throughput | 397 MB/sec |

Table 14 lists peakmarks storage test cases for this solution.

**TABLE 14. PEAKMARKS TEST RESULTS FOR TWO NODE**

| Test Case | Metric | Value |
|---|---|---|
| STO-RR (100% 8 KB Random Read) | IOPS | 64,340 |
| | Latency | 2.1 ms |
| STO-RWF (100% 32 KB Random Write) | IOPS | 24,860 |
| | Throughput | 1.7 ms |
| STO-SR (100% 1 MB Sequential Read) | Throughput | 809 MB/sec |
| STO-MIX (80% 8 KB Random Read, 20% 8 KB Random Write) | Read IOPS | 30,630 |
| | Read Latency | 1.6 ms |
| | Write IOPS | 6,178 |
| | Write Latency | 1.2 ms |

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